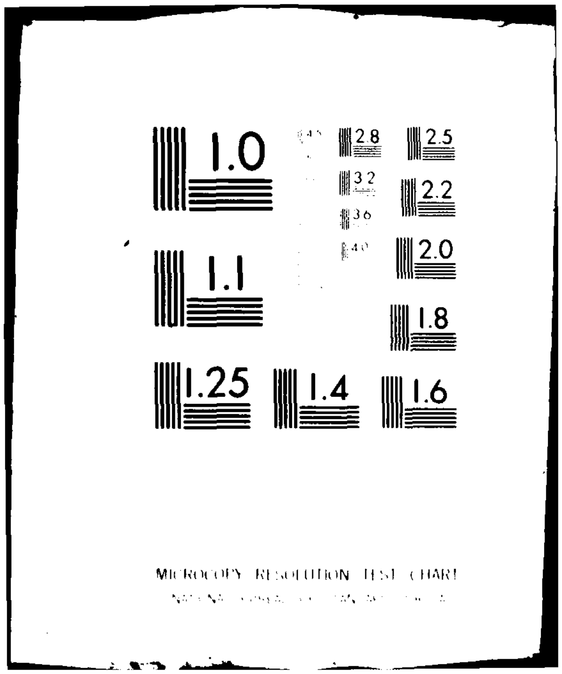
AD-A089 975 AERONAUTICAL RESEARCH LABS MELBOURNE (AUSTRALIA) F/G 9/5
A SIX-CHANNEL QUICK-LOOK UNIT FOR THE AERODYNAMICS DIVISION MKI--ETC(U)
FEB 80 A J FARRELL, S H CREED, I M KERTON
UNCLASSIFIED ARL/AERO-TM-319

1 OF 1

AD A
089975

END
DATE
FILMED
11-80
DTIC


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

UNCLASSIFIED

ARL-AERO-TECH-MEMO-319 LEVEL 12 AR-001-796

AD A089975

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

AERONAUTICAL RESEARCH LABORATORIES

MELBOURNE, VICTORIA

Aerodynamics Technical Memorandum 319

A SIX-CHANNEL QUICK-LOOK UNIT FOR THE AERODYNAMICS DIVISION MKI AIRBORNE DATA AQUISITION PACKAGE

A.J. FARRELL
S.H. CREED
I.M. KERTON
and
P. FERRAROTTO

Approved for Public Release.

COPY No 7

FEBRUARY, 1980

UNCLASSIFIED

80 10 7 065

(12)

AR-001-796

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

AERONAUTICAL RESEARCH LABORATORIES

11) F-L 80

14) -TM-

(9)

Aerodynamics Technical Memorandum 319

A SIX-CHANNEL QUICK-LOOK UNIT FOR THE AERODYNAMICS DIVISION MKI AIRBORNE DATA AQUISITION PACKAGE

A.J. FARRELL
S.H. CREED
I.M. KERTON
P. FERRAROTTO

SUMMARY

A ground-based unit is described which, when connected to a chart recorder, provides a post-flight analogue record of up to six channels simultaneously of data recorded on the Aerodynamics Division MKI Airborne Data Acquisition Package.

POSTAL ADDRESS: Chief Superintendent, Aeronautical Research Laboratories, P.O. Box 4331, Melbourne, Victoria 3001, Australia.

DOCUMENT CONTROL DATA SHEET

Security classification of this page: UNCLASSIFIED

1. DOCUMENT NUMBERS	2. SECURITY CLASSIFICATION
a. AR Number: AR-001-796	a. Complete document: UNCLASSIFIED
b. Document Series and Number: AERODYNAMICS TECHNICAL MEMORANDUM 319	b. Title in isolation: UNCLASSIFIED
c. Report Number: ARL-AERO-TECH-MEMO-319	c. Summary in isolation: UNCLASSIFIED

3. TITLE:

A SIX-CHANNEL QUICK-LOOK UNIT FOR THE AERODYNAMICS DIVISION MKI AIRBORNE DATA AQUISITION PACKAGE

4. PERSONAL AUTHORS: A.J. FARRELL S.H. CREED I.M. KERTON P. FERRAROTTO	5. DOCUMENT DATE: FEBRUARY, 1980 6. TYPE OF REPORT AND PERIOD COVERED:
7. CORPORATE AUTHOR(S): Aeronautical Research Laboratories	8. REFERENCE NUMBERS a. Task: NAV 74/4
9. COST CODE: 51-2090	b. Sponsoring Agency:
10. IMPRINT: Aeronautical Research Laboratories, Melbourne	11. COMPUTER PROGRAM(S) (Title(s) and language(s)):

12. RELEASE LIMITATIONS (of the document):

Approved for Public Release.

12-0. OVERSEAS:	N.O.		P.R.	1	A		B		C		D		E	

13. ANNOUNCEMENT LIMITATIONS (of the information on this page):

No Limitation.

14. DESCRIPTORS:		15. COSATI CODES:
Flight recorders.	Data display.	0902
Data processing.	Digital to analogue	1403
Data converters.	converters.	

16. ABSTRACT:

A ground-based unit is described which, when connected to a chart recorder, provides a post-flight analogue record of up to six channels simultaneously of data recorded on the Aerodynamics Division MKI Airborne Data Acquisition Package.

CONTENTS

1. INTRODUCTION

The Aerodynamics Division MKI Airborne Data Acquisition Package [1] is a unit which records in flight up to 32 channels of analogue data in digital form. The channels may be sampled at rates of 60, 30 or 15 Hertz within an overall capacity of 1200 samples per second. Each sample is recorded as a digital word 12 bits long. The flight package includes a quick-look facility, which allows any channel, after recording, to be converted back to analogue form and monitored on an oscilloscope, while the recording is in progress.

The unit described in this memorandum is basically a ground-based six-channel version of the flight quick-look section. The output of the unit is recorded on any six-channel paper trace recorder. An example of the output is shown in FIG. 1.

The unit is principally intended to provide a post-flight check of the flight record, but it is sufficiently accurate for the output traces to be used for analysis.

An additional feature of the unit, is that a decoded digital output, with appropriate timing pulses, is provided for use with a transcription unit [2], which converts the data into a form suitable for recording on 7-track computer compatible tape.

The following sections describe the operation, construction and operating procedure of the unit.

2. OUTLINE OF OPERATION

To introduce this section, a brief outline of the data recording format will be given. A more detailed description is given elsewhere [1].

In the recording package, a typical transducer [FIG. 2] is conditioned with a conditioning amplifier, demodulated and low-pass filtered. The conditioned signal is sampled at the chosen rate by the multiplexer. The sample is converted into a 12-bit parallel digital word by the Analogue-to-Digital Converter (ADC), after which the word is converted from parallel to serial form in the serializer. The encoder converts the serial word into a form suitable for recording on the magnetic tape recorder. The data channels are divided so that one half of the channels are recorded on track 1 of the recorder while the other half is recorded on track 2.

The sampling, conversion, serializing and encoding operations are all controlled from a master oscillator by the control electronics.

On the magnetic tape, the serial data words [FIG. 3] are separated by 4-bit wide gaps, while the 12-word frames (or input scanning cycles) on each track are separated by 12-bit gaps.

Two alternative encoding arrangements are available [FIG. 4], with the binary pulse amplitude modulation (BPAM) method being the one normally used.

In the six-channel quick look unit, the replayed signal from each track of the recorder is decoded i.e. the 12-bit parallel words are recovered from the serial data stream, and in addition, pulses corresponding to the gaps between the words and the frames are generated [FIG. 5]. The parallel words are converted to analogue form by a digital-to-analogue converter (DAC).

A data channel is selected by dialling a number on one of the front-panel thumbwheel switches. The quick look channel select circuit uses the dialled number and the decoded gap and clock pulses to generate a sample pulse. This sample pulse at the sample and hold (SAH) circuit control gate, selects and holds at the SAH output, the value for the required channel from the selected track. The SAH output is then displayed on the chart recorder.

Each of the six quick-look channels operates in the same way.

The following sections discuss the operation of the system in more detail and a detailed operating procedure is included in the Appendix.

3. DETAILED DESCRIPTION OF OPERATION

3.1 Decoding

3.1.1 BPAM decoding

The function of the decoder is to extract from the recorder replay signal the serial data and clock, and an inter-word gap (IWG) pulse for each word.

From FIGS. 6 and 7, the recorder replay signal selected by the switch appears, after amplification, at the input of comparator 1. Outputs corresponding to the logic 1's in the data stream constitute the serial data input to the next stage of decoding. Comparator 2 triggers on every cycle of the inverted replay signal to produce the "raw clock". The raw clock triggers a delay monostable to provide the shift register clock (see section 3.2). The negative going edge of the shift register clock is timed to coincide with the position of the serial data logic 1's.

The IWG pulse is generated from the raw clock pulses. The "on" time of the monostable 1 is greater than the period between the raw clock pulses, so the output remains at a logic "1" throughout a word. When a gap occurs, the output falls, triggering monostable 2, thus producing the IWG pulse.

The BPAM decoder is mounted on two printed circuit boards 57/273 and 57/274.

3.1.2 Harvard decoder

The function of the Harvard (Bi-phase) decoder is the same as the BPAM decoder, namely, to extract from the replayed signal the serial data, serial clock and IWG pulses.

Considering FIGS. 8 and 9, the replayed signal from the recorder is amplified and fed to the inputs of two comparators, one of which detects positive signals and the other negative signals (with respect to ground). The combined outputs of these comparators constitutes the serial data.

The serial clock and the IWG pulse are derived from the inverted serial data. The negative transition of the inverted serial data at the start of each bit period sets the 'Q' of the clock timing flip-flop, which is connected as a latch, to a logic '1'. This allows pulses from an oscillator to clock a counter. After eight pulses, the counter 'D' line changes state, resetting the flip-flop 'Q' to a logic 'O' and stopping the counting. This constitutes one serial data clock cycle. The oscillator frequency is arranged so that the time for eight pulses is 75% of the bit period.

The serial clock at this stage has 13 pulses per frame instead of 12. The clock pulse limiting circuit is employed to eliminate the unwanted last pulse. The '$\bar{Q}$' of a latch-connected flip-flop within the clock limiting circuit is set by the IWG pulse to a logic '1'. A counter in the limiter counts 12 incoming serial clock pulses, then resets the flip-flop '$\bar{Q}$' to a logic 'O', cutting off the last pulse.

The IWG pulse is derived in the same way as in the BPAM decoder.

The Harvard decoder is mounted on two printed circuit boards, 57/271 and 57/272, which are direct replacements for the two BPAM decoder boards.

3.2 Serial to Parallel Converter

From FIG. 10(a) and (b), the serial data from the decoder is clocked by the negative-going edges of the serial data clock into a 12-bit shift register. When the register is full, the IWG pulse transfers the 12-bit parallel word from the shift register to the output latch. The circuit is mounted on printed circuit board 57/235.

3.3 Quick Look Channel Selection

The function of the quick look (QL) section is to provide a control pulse which will enable successive samples of a single channel from the recorded data stream to be extracted and displayed in analogue form on a chart recorder. Each of the six QL selector circuits is identical. The operation of the QL system is described in two parts, the first part being the basic QL facility, and the second part being the sub-multiplexer section.

In the QL channel select circuit, FIG. 11(a), a number which is associated with a particular channel (section 5) is dialled on the front panel channel select switch. A digital comperator compares the number with a count of the IWG pulses. When the number and the count are the same, the comparator output goes to a logic '1' [FIG. 11(b)] and assuming that the sub-mux ON/OFF switch is off, the next IWG pulse passes through the AND gate to the Sample and Hold (SAH) control gate (section 3.4). The control pulse transfers the SAH input value at the trailing edge of the pulse to the SAH output. This is the required value of the selected channel and is recorded on the chart recorder. The value is updated by the successive control pulses.

Dealing now with the sub-multiplexer channel select circuit, it can be seen from TABLE 1 that the sequence in which particular sub-multiplexed channels are recorded is related to the two least significant bits (LSB's) of the frame count (FC) word i.e. the first word of each frame (FIG. 2). From FIGS. 12 and 13, the First IWG Pulse Selector circuit allows the first IWG pulse only of each frame through as the 2-bit latch control pulse. This pulse stores the two least significant bits of the "FC" word when a 4:1 sub-multiplexed channel is selected (B1 is set to a logic '0' when a 2:1 sub-multiplexed channel is selected). If the bits stored in the 2-bit latch match the binary code of the number selected on the thumb-wheel switch, the comparator gives an output which allows the QL latch control pulse to be transmitted during that frame. As the switch number, N, is changed, the position in time of the comparator output changes appropriately.

When a 2:1 sub-multiplexed channel is selected, the output of the SAH is updated once every 1/30 of a second, instead of every 1/60 of a second with a normal channel i.e. directly recorded channel. In the same way a 4:1 sub-multiplexed channel is updated once every 1/15 of a second.

3.4 Sample and Hold

The output of the DAC is in the range 0 to -10 volts. A conditioning amplifier is provided before the input to each of the six sample and hold (SAH) circuits to translate the input to the more convenient (from the chart recorder point of view) -5 to +5 volt range. The SAH itself is a commercially available National Semiconductor AH 0023 C. Four SAH circuits are mounted on each 57/257(R1) printed circuit board, so that two boards are required to provide the six outputs to the chart recorder.

3.5 Four Line Power Drivers

The inter-word gap (IWG) pulse, bit 1 and clock pulses which drive all six of the QL channel selector circuits are derived from the track 1 decoder only to simplify the wiring. Without buffering the driving capability of the transistor-transistor logic (TTL) gate outputs in the decoder would be exceeded. The required buffering is provided on printed circuit board 57/252(R2) by four standard TTL SN 7440 line drivers.

3.6 Power Supply

The +5 volts, +15 volt and -15 volt supplies required by the unit are supplied by two identical regulated power supplies mounted on printed circuit boards 57/162(R1) with the associated transformers bolted on the side panels of the unit. The circuit drawings of these supplies, as well as details of all the other circuits described, are available from the authors.

4. MECHANICAL CONSTRUCTION

The unit is mounted in two ELNASET card frames which are bolted together to form a single assembly. The top section contains all the decoding and channel selection circuits, with the channel selector switches mounted on the front. The lower section houses the power supplies, sample and holds, the line drivers and the power supply transformers. The top and bottom sections are interconnected via a CANNON sub-miniature 37-pin plug and socket. Detailed layout and inter-wiring diagrams are available from the authors.

5. CONCLUSION

The unit described above has proved to be a valuable adjunct to the MKI Flight Data Acquisition Package, enabling flight records to be examined immediately after test flights, and allowing faults in the flight recording system to be identified and corrected.

By replacing four printed circuit cards and modifying some timing capacitors in the QL section, the unit may be adapted for use with the proposed MKII flight recording package.

REFERENCES

1. 'The Aerodynamics Division Airborne Data Acquisition Package MKI', A.J. FARRELL, Aerodynamics Note 386, 1979.

2. 'An Improved Data Transcriber for the Aerodynamics Division MKII Flight Data Recording Package'. A.J. FARRELL, Aerodynamics Tech. Memo. (in preparation) 1979.

APPENDIX

OPERATING PROCEDURE

The six-channel quick look unit is normally housed in a rack together with a RACAL T5000 7-track tape recorder with associated transcription unit, and a BECKMAN type chart recorder. In front of the rack is a KUDELSKI NAGRA IV-SJ in its transcription cradle [FIG. 14] .

The front panel of the six-channel Quick-Look unit has six groups of controls associated with the six chart recorder outputs. Each of the groups [FIG. 15] has three switches and three thumbwheel number selector switches. The flight data channels to be displayed on the chart recorder are selected by setting the controls appropriately, as described below.

1. Clean NAGRA and RACAL tape recorder heads with metholated spirits.

2. Switch on all equipment. If possible leave RACAL on for 20 minutes before using to reduce possibility of vacuum failures.

3. If transcription required, load RACAL with tape (refer RACAL T5000 operating manual).

4. Load NAGRA tape.
   N.B. NAGRA recorder MUST be in transcription cradle.

5. Zero chart recorder pens and select desired sensitivity and chart speed. (Refer OFFNER Dynograph model 504A manual).

6. Select data channels to be displayed.
   Set QL channel select switches [FIG. 15] according to procedure outlined in FIG. 16 and TABLE 2.

7. Select required section of tape on NAGRA tape recorder for QL and/or transcription.

8. If transcribing, set RACAL recorder to 'operate'.

9. Start chart recorder, then set NAGRA tape recorder to replay with loud speaker.

APPENDIX (CONTD.)

10. Push 'event' button on 6-channel QL unit to mark the chart record as required.

11. Transcribe data as required [2].

12. When a passage is completed, switch off the NAGRA recorder and chart recorder and proceed to the next section of the flight tape, repeating steps 7 to 12.

13. On completion, rewind NAGRA tape and store; rewind RACAL tape, if used, and send to computer centre.

14. Switch off all equipment.

TWO LEAST SIGNIFICANT BITS OF THE FRAME COUNT WORD (FC)		TRACK 1 CHANNELS			TRACK 2 CHANNELS		
B1	B0	FRAME POSITION 10 (2:1)	FRAME POSITION 11 (2:1)	FRAME POSITION 12 (4:1)	FRAME POSITION 10 (2:1)	FRAME POSITION 11 (4:1)	FRAME POSITION 12 (4:1)
0	0	15	19	25	17	21	29
0	1	16	20	26	18	22	30
1	0	15	19	8	17	23	31
1	1	16	20	28	18	24	32
0	0	15	19	25	17	21	29
0	1	16	20	26	18	22	30
1	0	15	19	8	17	23	31
1	1	16	20	28	18	24	32

TABLE 1. RELATIONSHIP BETWEEN THE TWO LEAST SIGNIFICANT BITS OF THE FRAME COUNT AND THE RECORDED SUB-MULTIPLEXED CHANNELS (Two cycles of 4:1 and four cycles of 2:1 sub-multiplexing shown).

TABLE 2. DATA FRAME/QUICK LOOK RELATIONSHIPS

TRACK 1 DATA CHANNEL ALLOCATION	FC	BC	1	3	5	7	9	11	13	15 / 16	19 / 20	25 / 26; [illegible] / 2[illegible]
QL CHANNEL SELECT NUMBER *	0	1	2	3	4	5	6	7	8	9	10	11
TRACK 2 DATA CHANNEL ALLOCATION	FC	BC	2	4	6	27	10	12	14	17 / 18	21 / 22; 23 / 24	29 / 30; 31 / 32

2:1 SUB-MUX

SUB-MUX CHANNEL SELECT NUMBER +

0 / 1

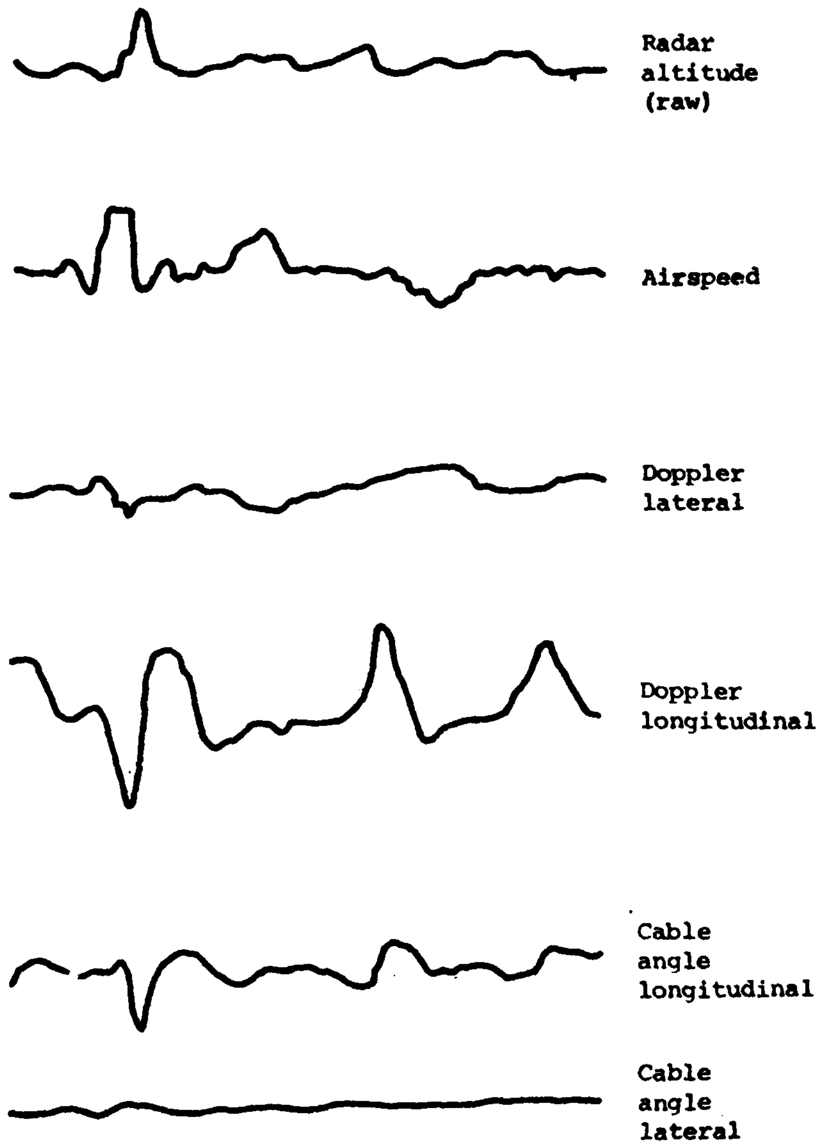
4:1 SUB-MUX

SUB-MUX CHANNEL SELECT NUMBER +

0 / 1
2 / 3

* M_2M_1 IN FIG. 14

+N IN FIG. 14



1 sec ≡ 1 mm

FIG 1. TYPICAL OUTPUT TRACE - SIX CHANNEL QUICK-LOOK UNIT

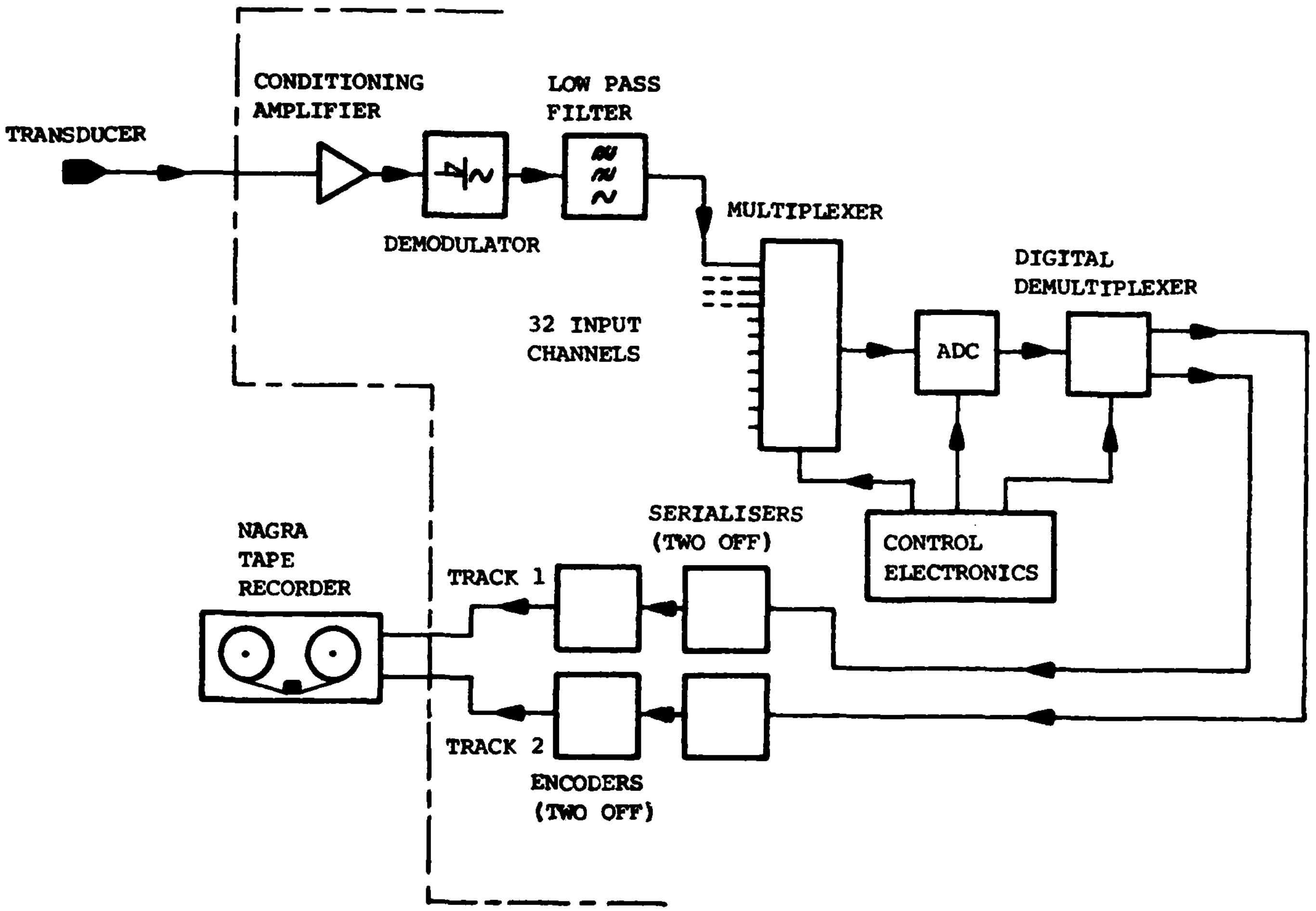


FIG. 2 FLIGHT PACKAGE SIMPLIFIED BLOCK DIAGRAM

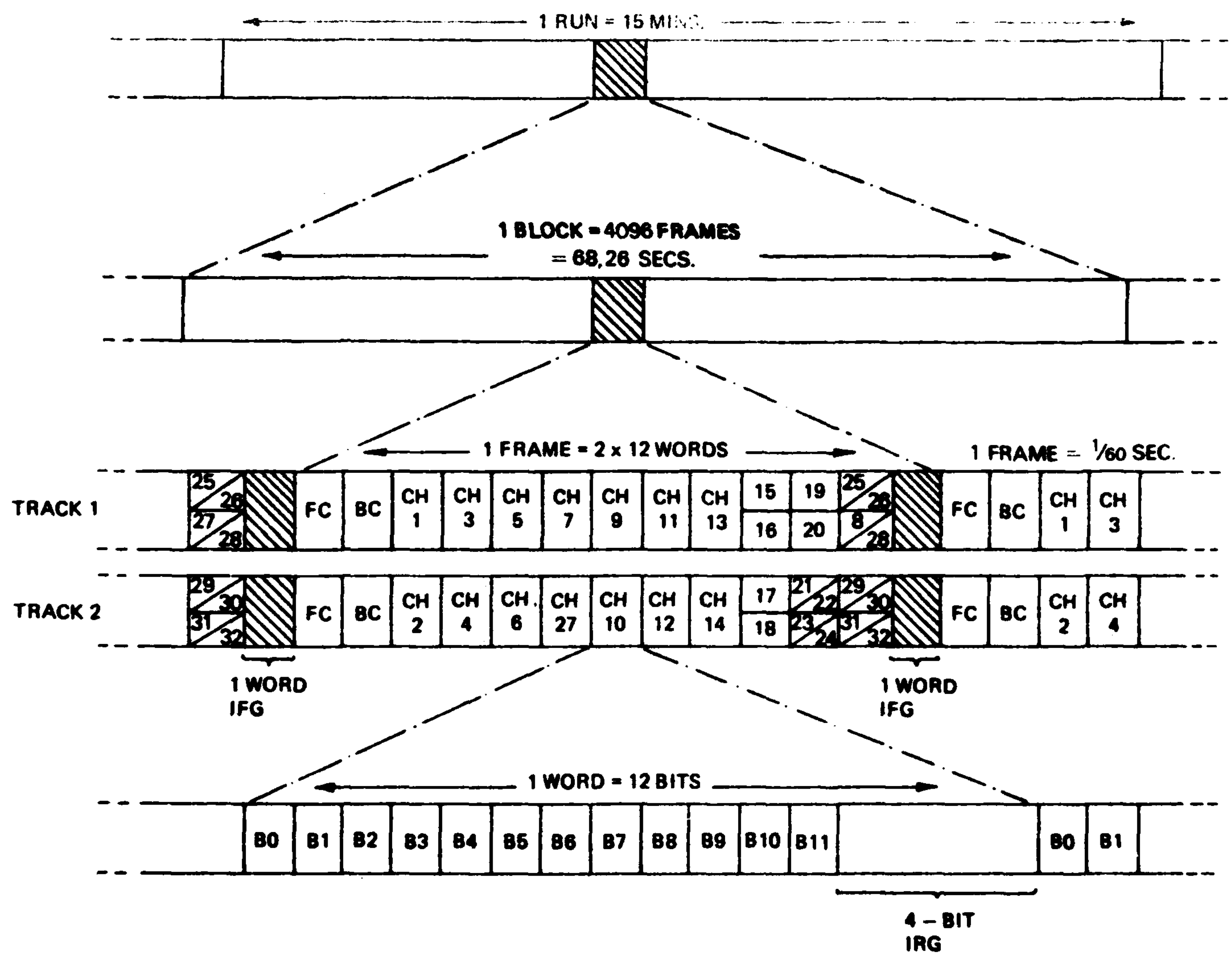


FIG. 3 RECORDING FORMAT

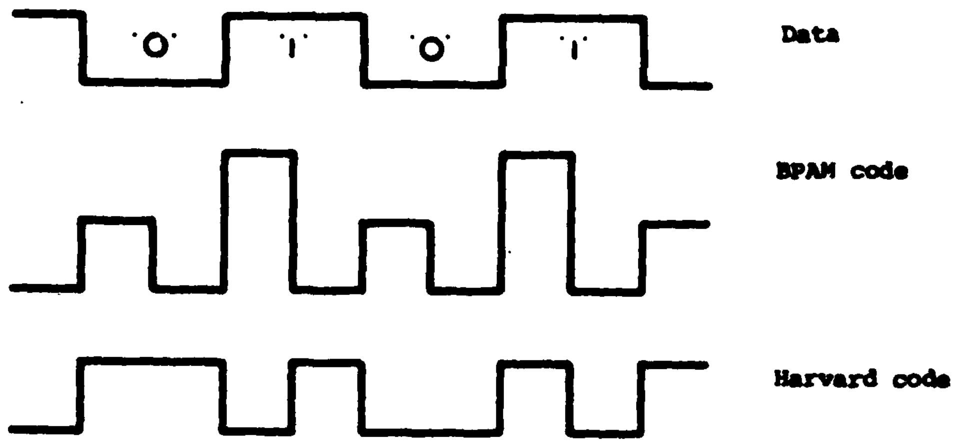


FIG. 4 ENCODING FORMATS

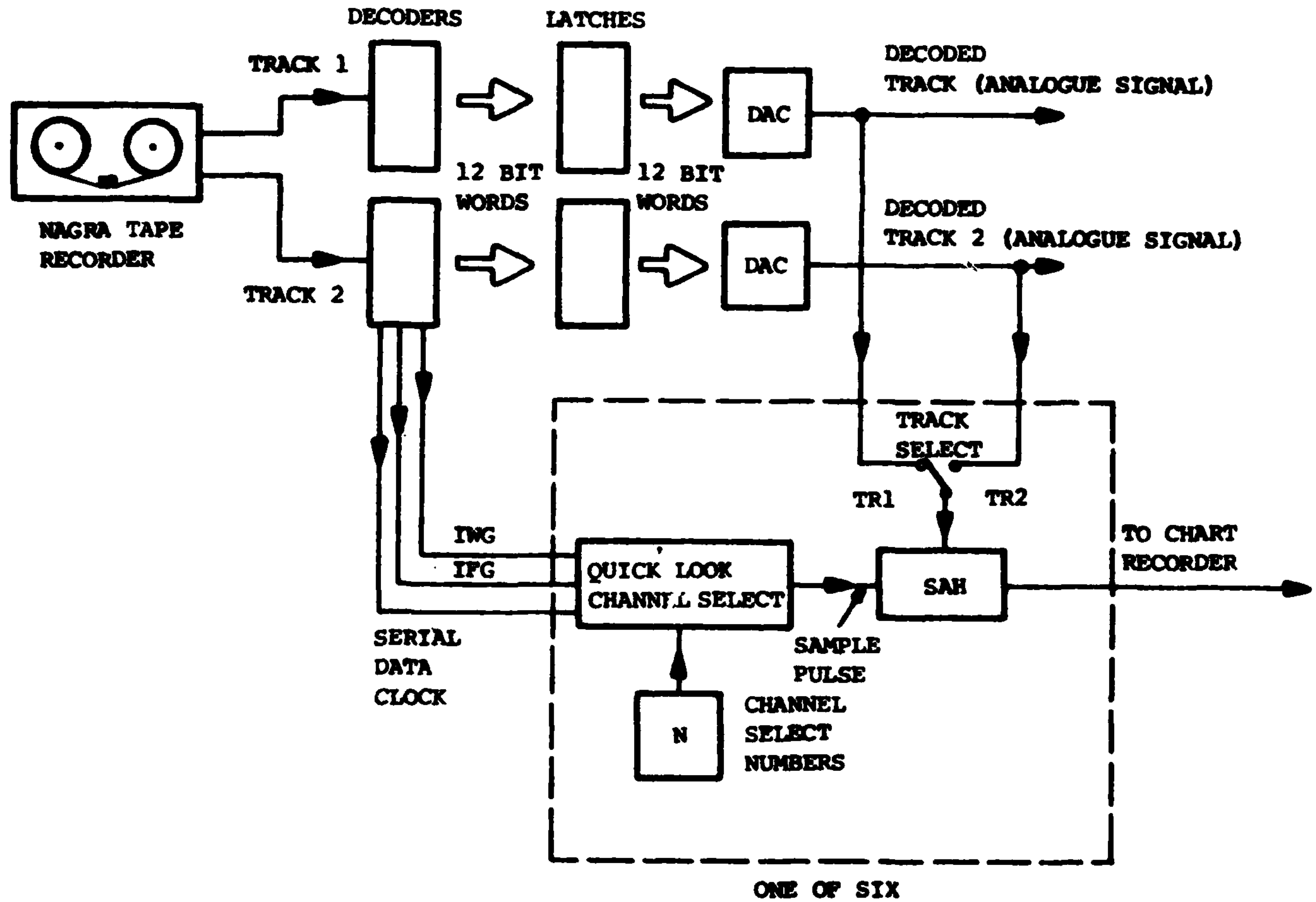


FIG. 5 SIX CHANNEL QUICK LOOK UNIT SIMPLIFIED BLOCK DIAGRAM

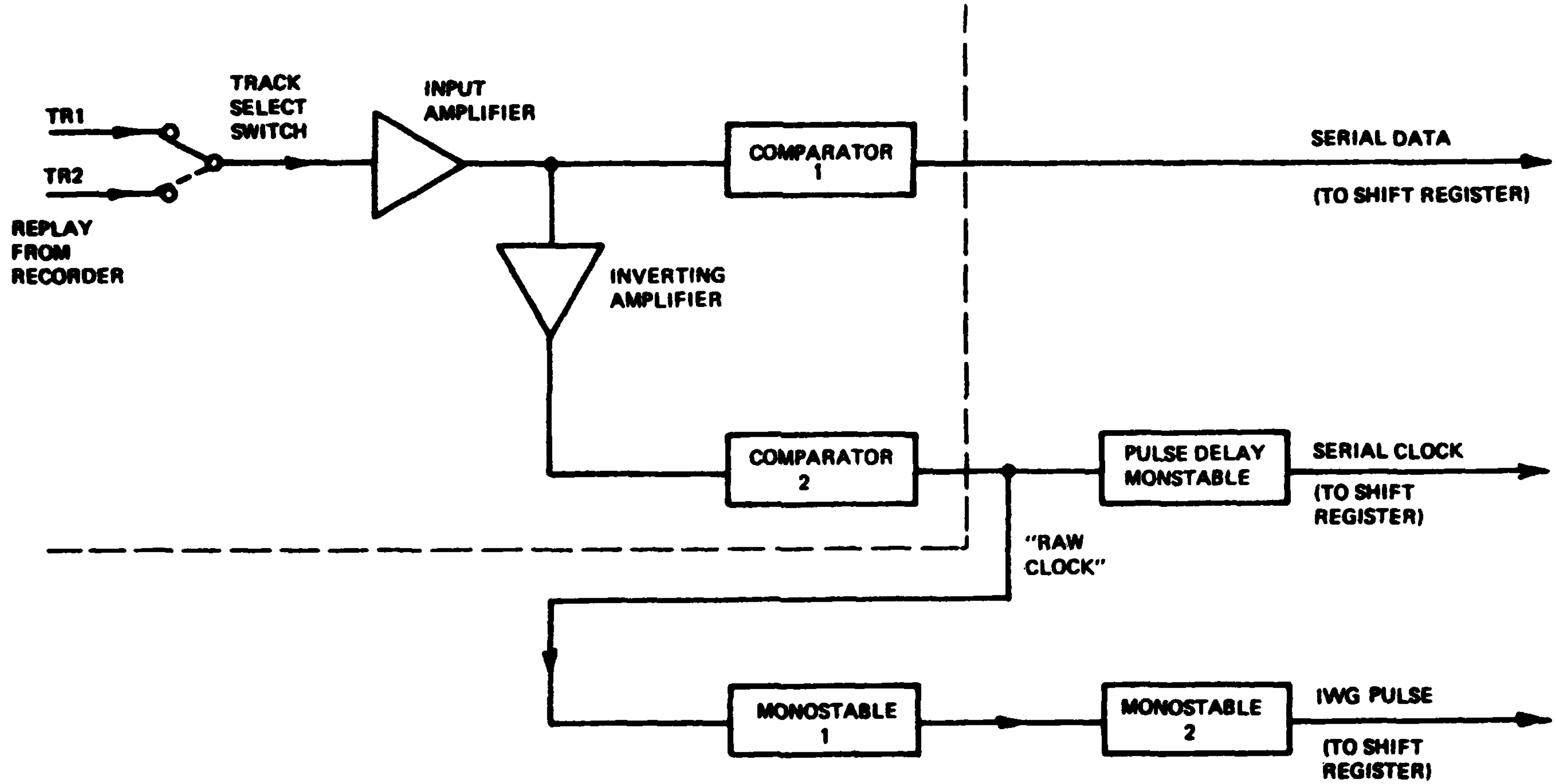


FIG. 6 BPAM DECODER BLOCK DIAGRAM

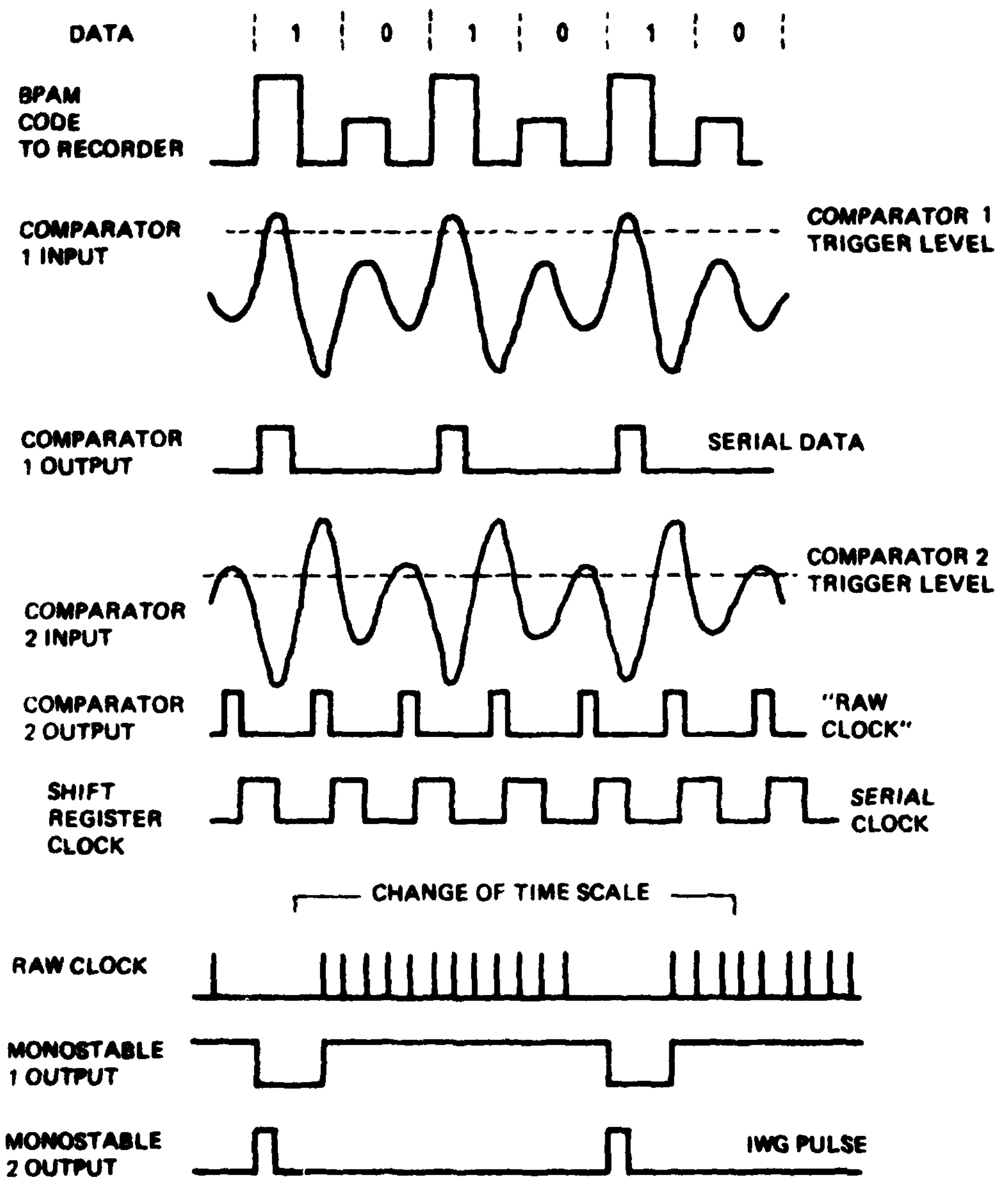


FIG. 7 BPAM DECODER TIMING DIAGRAM

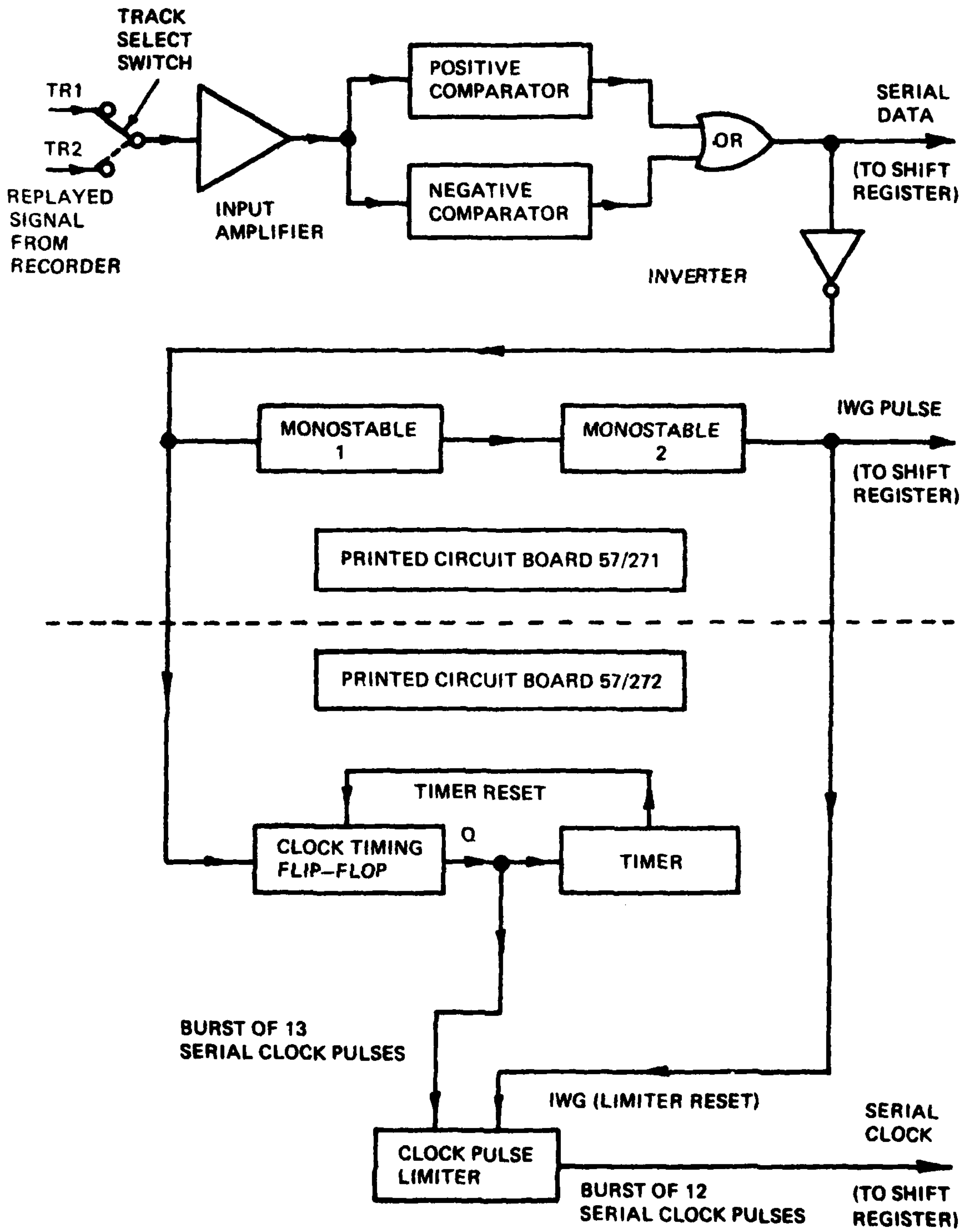


FIG. 8 HARVARD (BI–PHASE) DECODER TIMING DIAGRAM.

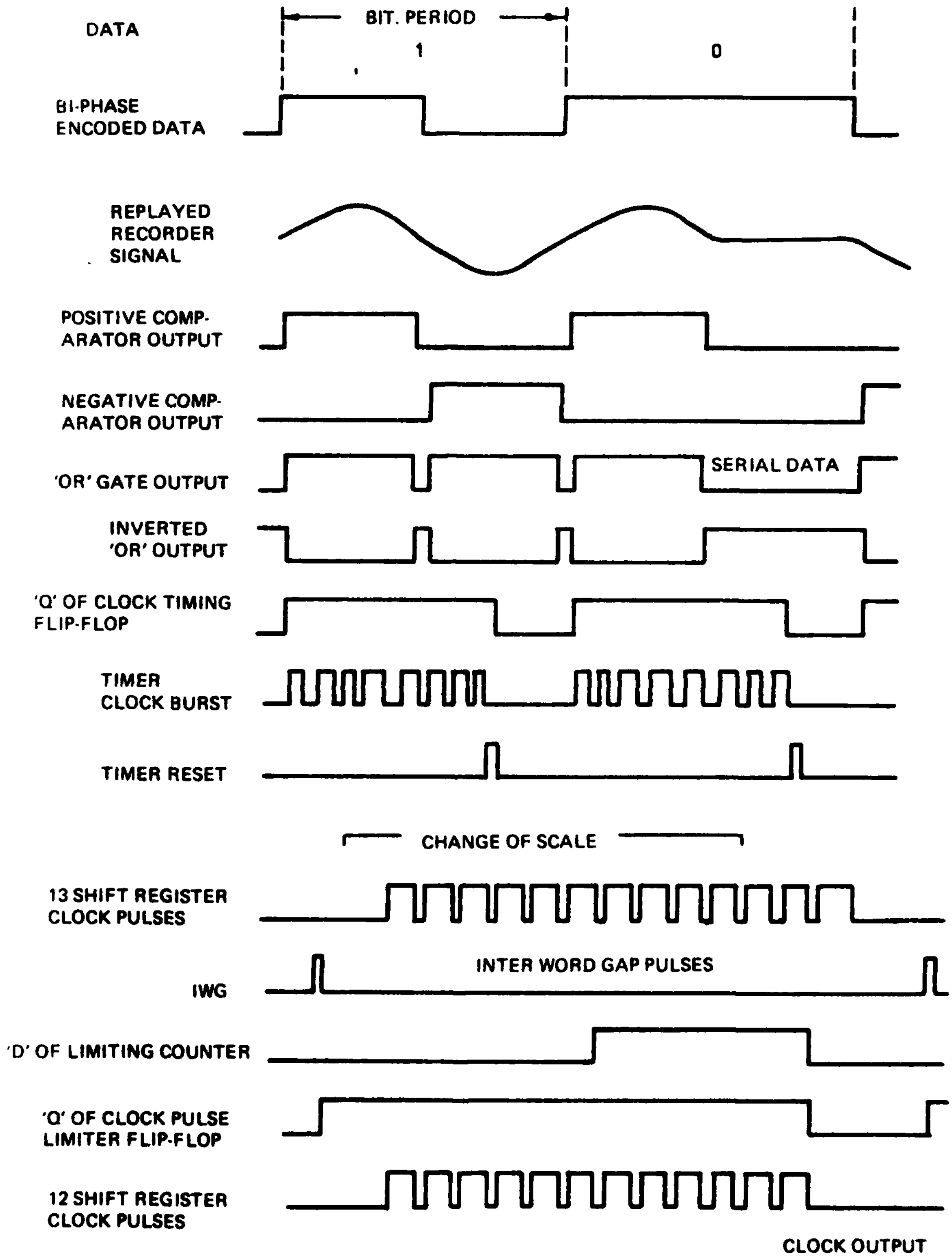


FIG. 9 HARVARD (BI-PHASE) DECODER TIMING DIAGRAM

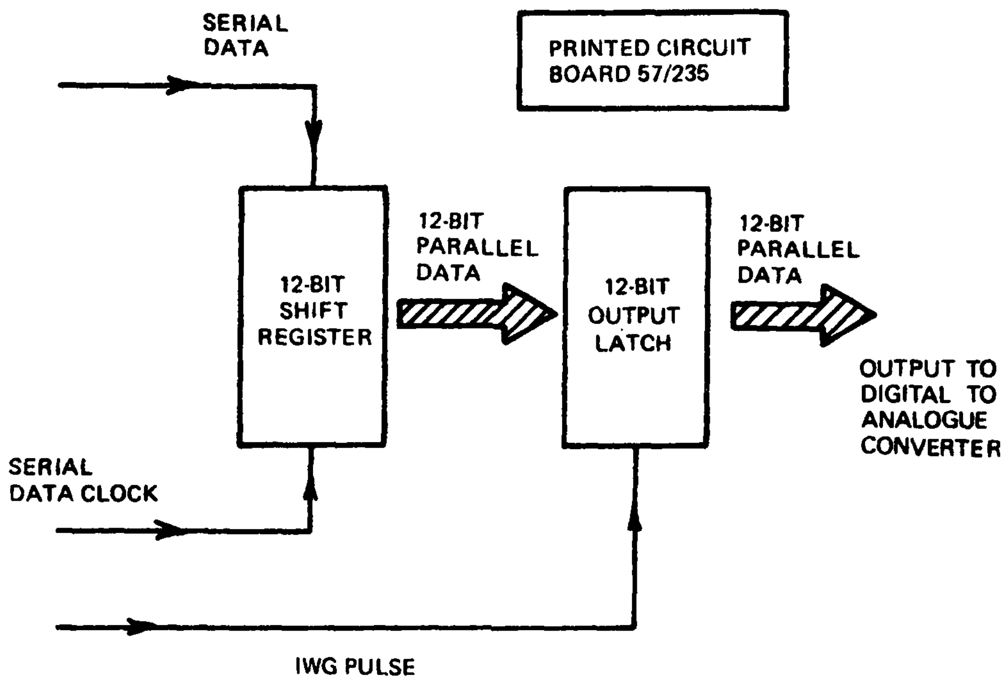


FIG. 10 (a) SERIAL TO PARALLEL CONVERTER BLOCK DIAGRAM

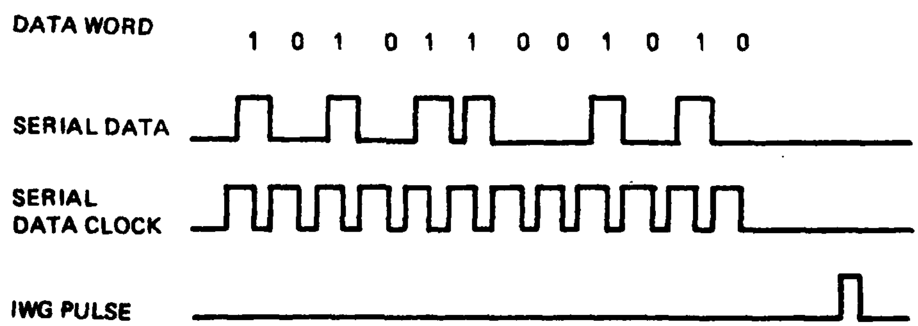


FIG. 10 (b) SERIAL TO PARALLEL CONVERTER TIMING DIAGRAM

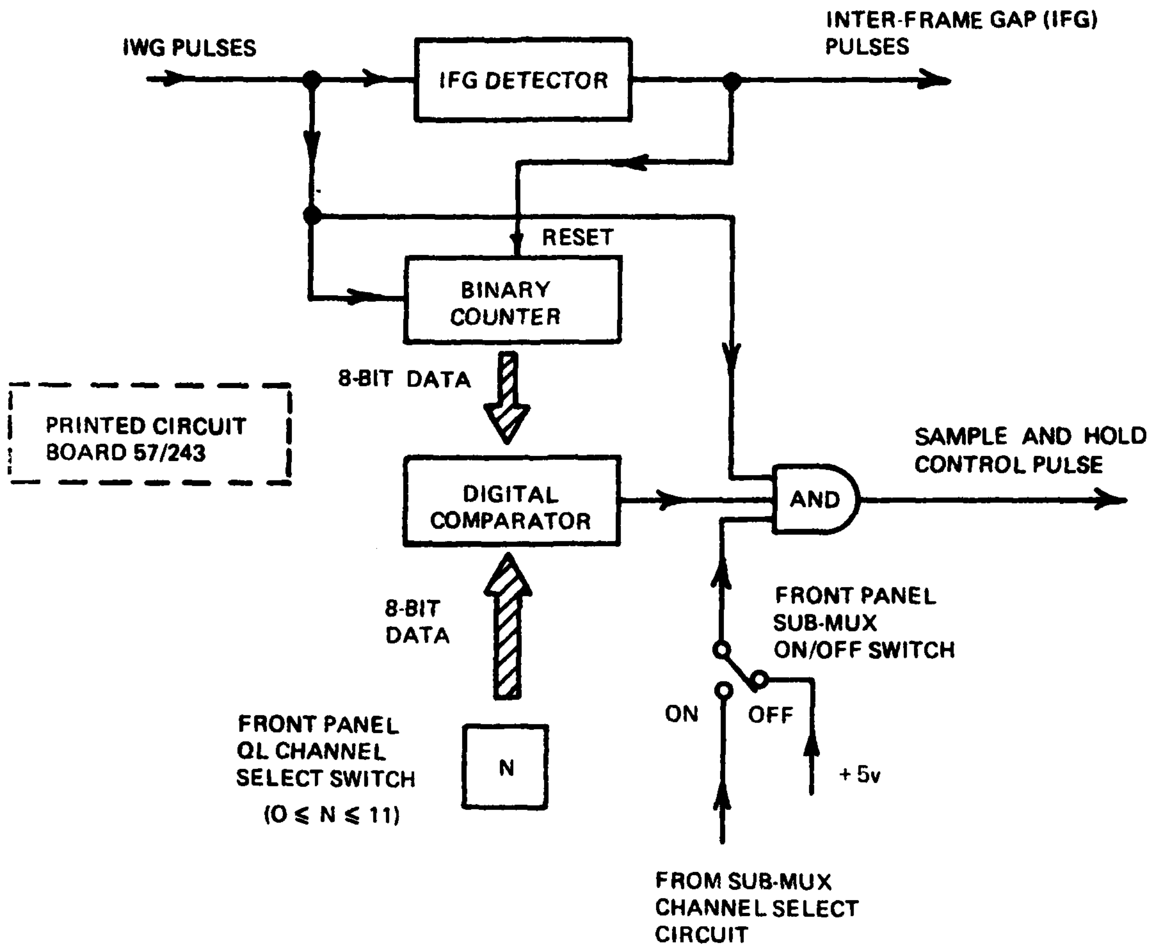


FIG. 11 (a) QL CHANNEL SELECT CIRCUIT BLOCK DIAGRAM

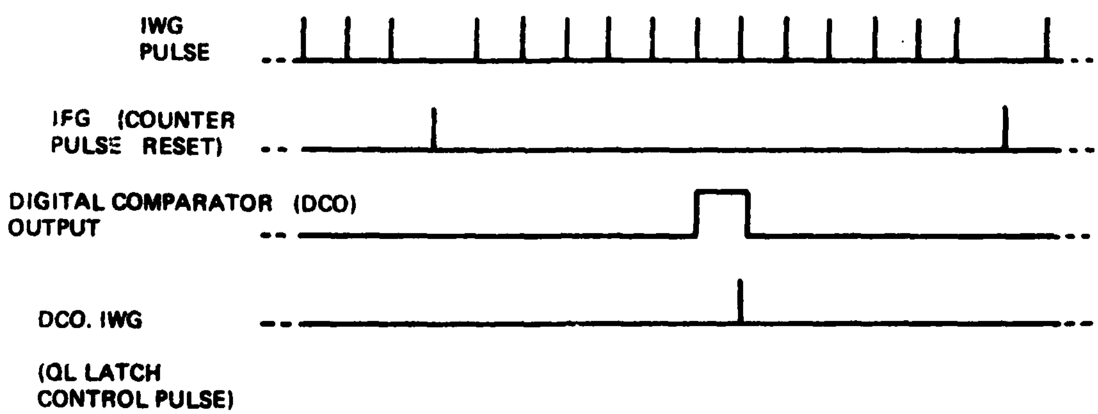


FIG. 11 (b) QL CHANNEL SELECT CIRCUIT TIMING DIAGRAM.

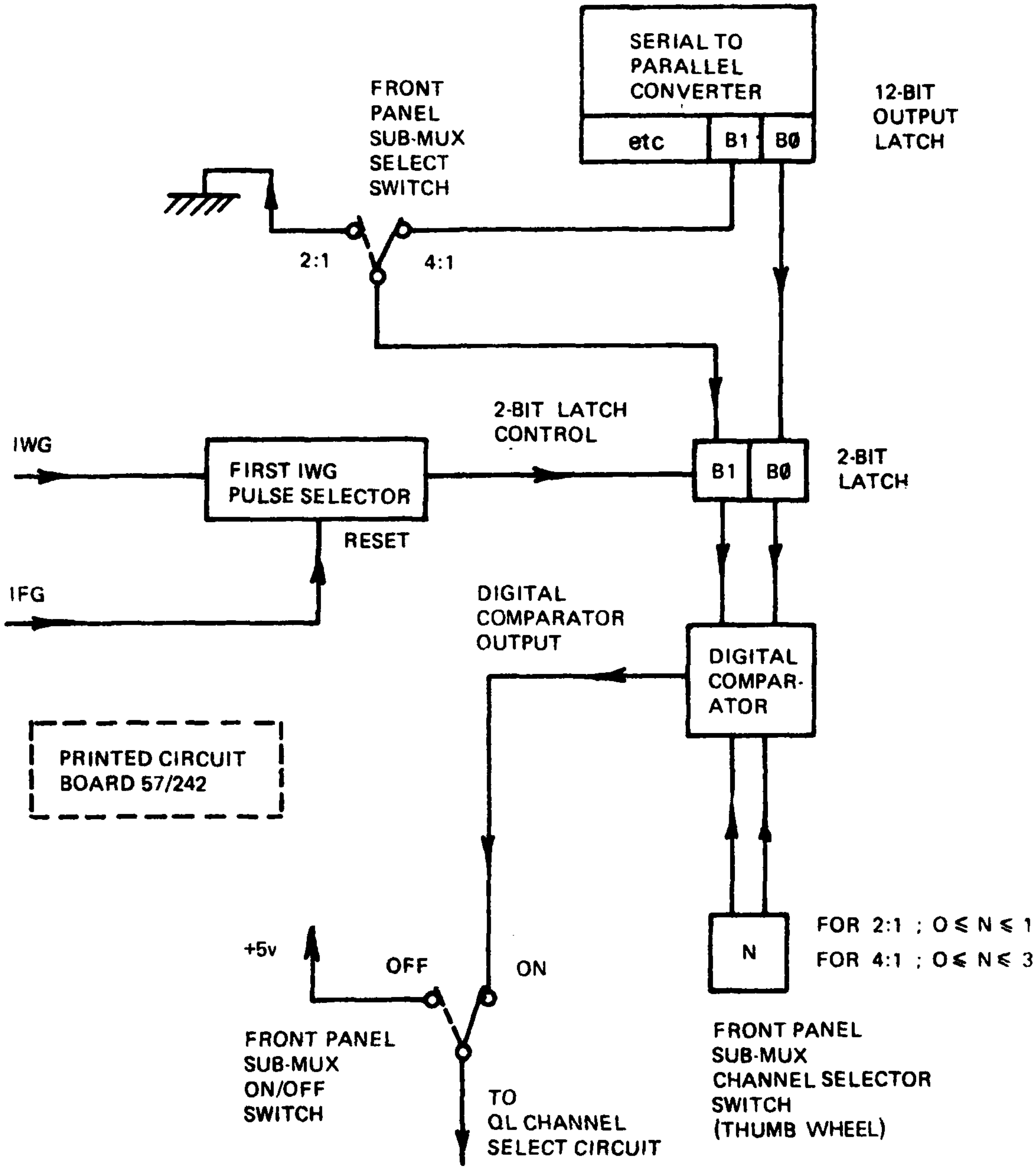


FIG 12 SUB-MULTIPLEXER CHANNEL SELECT CIRCUIT BLOCK DIAGRAM

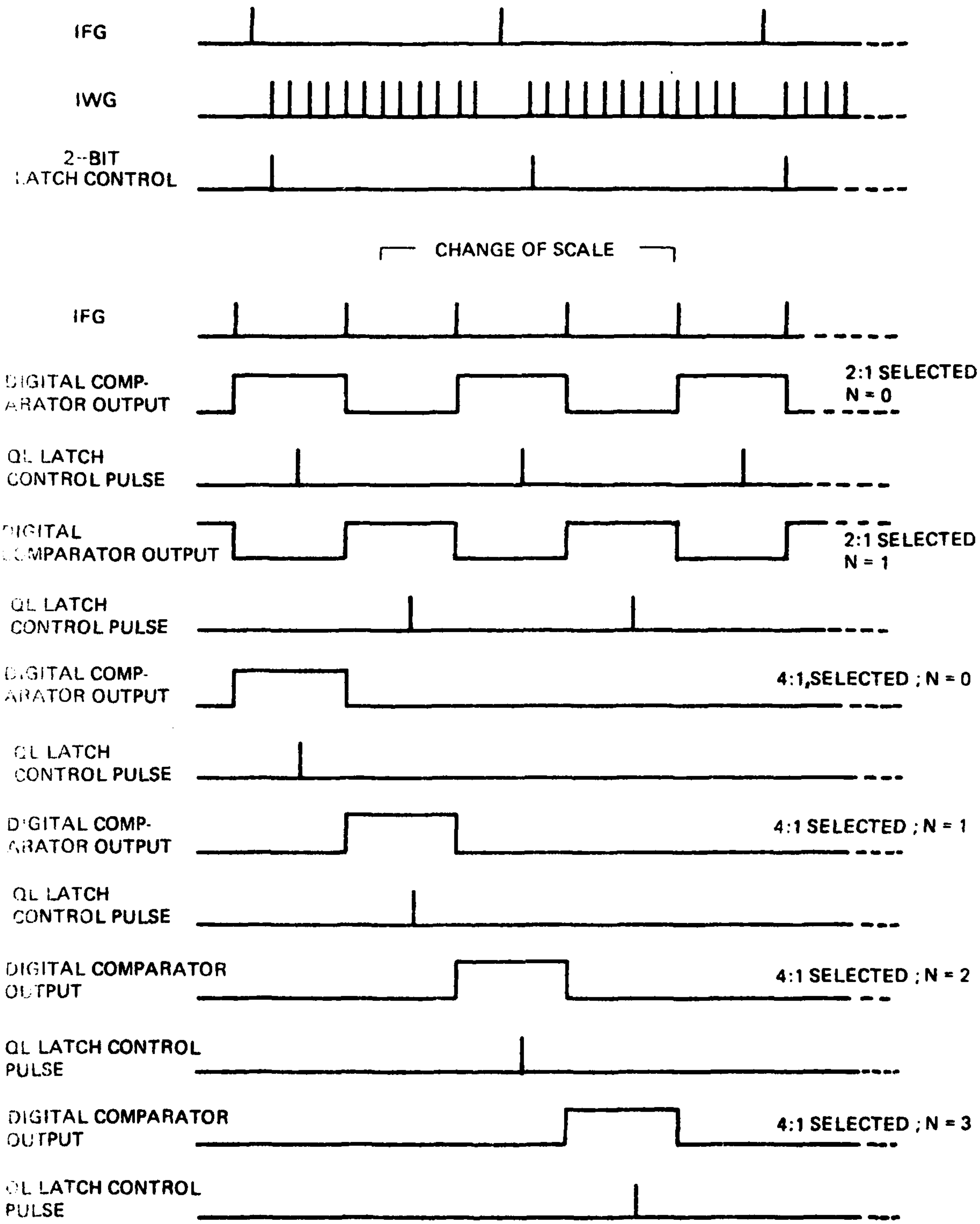


FIG. 13 SUB-MULTIPLEXER CHANNEL SELECT CIRCUIT TIMING DIAGRAM

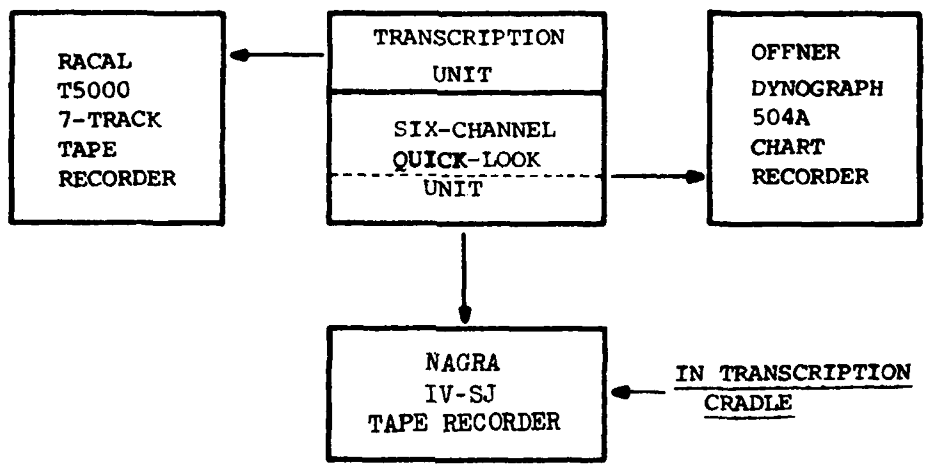


FIG. 14 GROUND-BASED QUICK-LOOK AND TRANSCRIPTION ARRANGEMENT

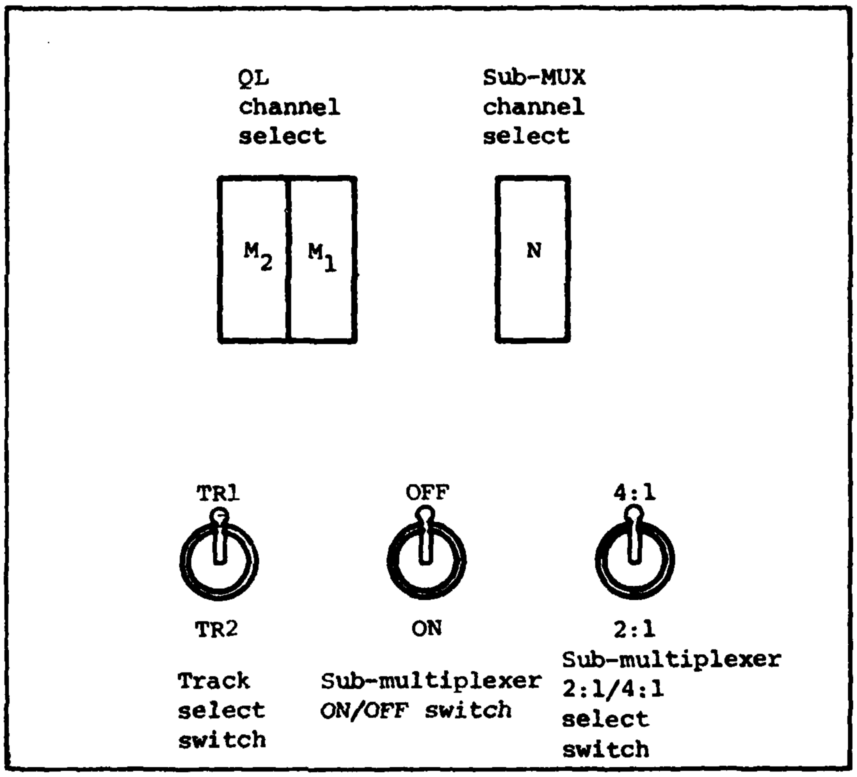


FIG. 15 QL CHANNEL SELECT CONTROLS - ONE OF SIX

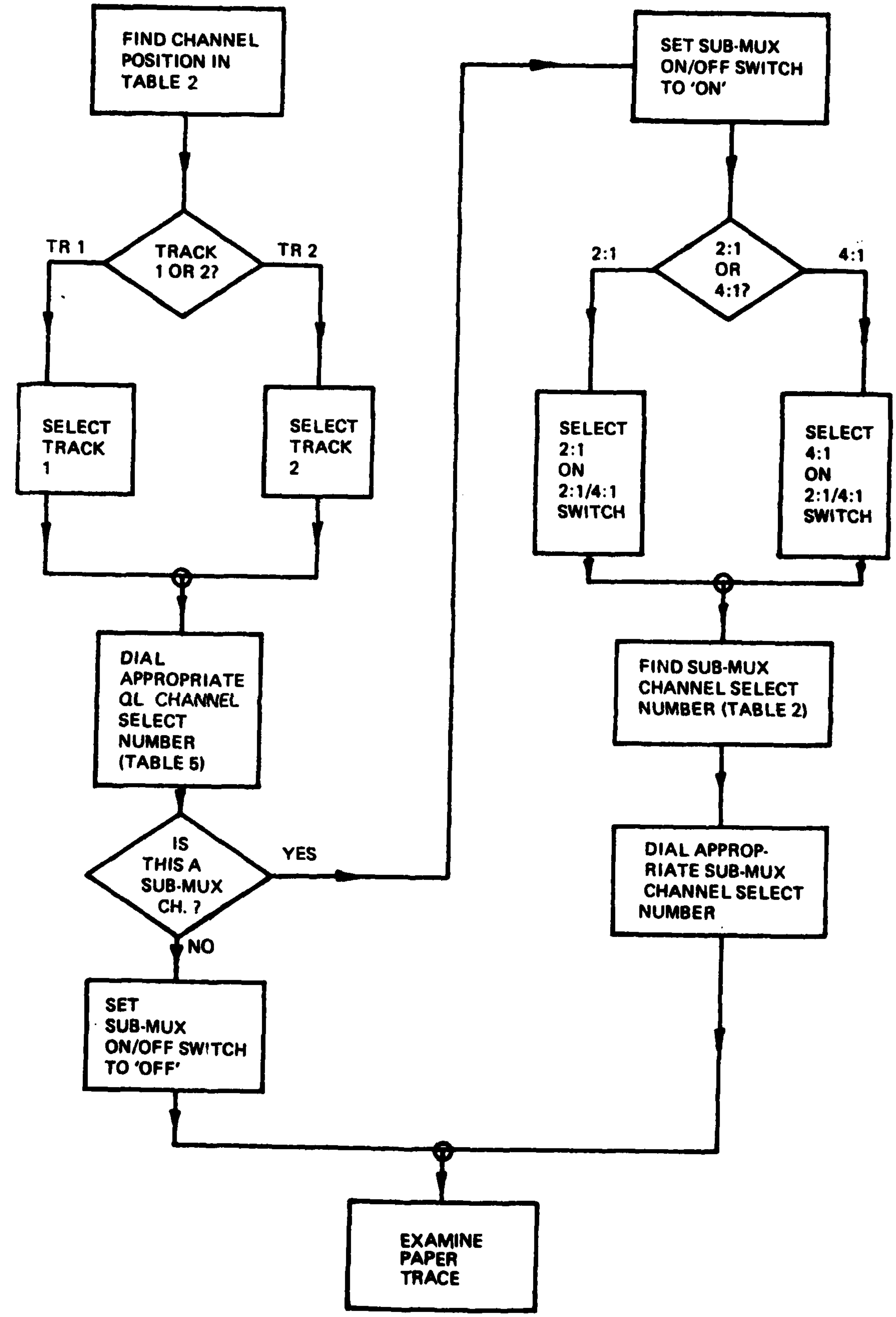


FIG. 16 QUICK LOOK CHANNEL SELECT PROCEDURE

DISTRIBUTION

	COPY NO.
AUSTRALIA	
Department of Defence	
Central Office	
Chief Defence Scientist	1
Deputy Chief Defence Scientist	2
Superintendent, Science and Technology Programs	3
Australian Defence Scientific & Technical Representative (UK)	-
Counsellor, Defence Science (USA)	-
Joint Intelligence Organisation	4
Defence Library	5
Assistant Secretary, D.I.S.B.	6-21
Aeronautical Research Laboratories	
Chief Superintendent	22
Library	23
Superintendent - Aerodynamics Division	24
Divisional File - Aerodynamics	25
Authors: A.J. Farrell	26
S.H. Creed	27
I.M. Kerton	28
P. Ferrarotto	29
Instr. Grp. File	30-31
Materials Research Laboratories	
Library	32
Defence Research Centre Salisbury	
Library	33
SPARES	34-43